



The PBL Projects

Challenge Overview

- Industry Partner: Forest Products Laboratory, US Department of Agriculture, Madison, Wisconsin
- In this challenge, you will be part of a team to design a series of scientific tests to evaluate the mechanical properties of a new forest product.
- STEM principles reinforced:
 - Mechanical/physical properties of materials
 - Scientific testing methods
 - Nondestructive testing
- Prerequisite knowledge required:
 - Physical science
 - Scientific inquiry and experimentation



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INTRODUCTION

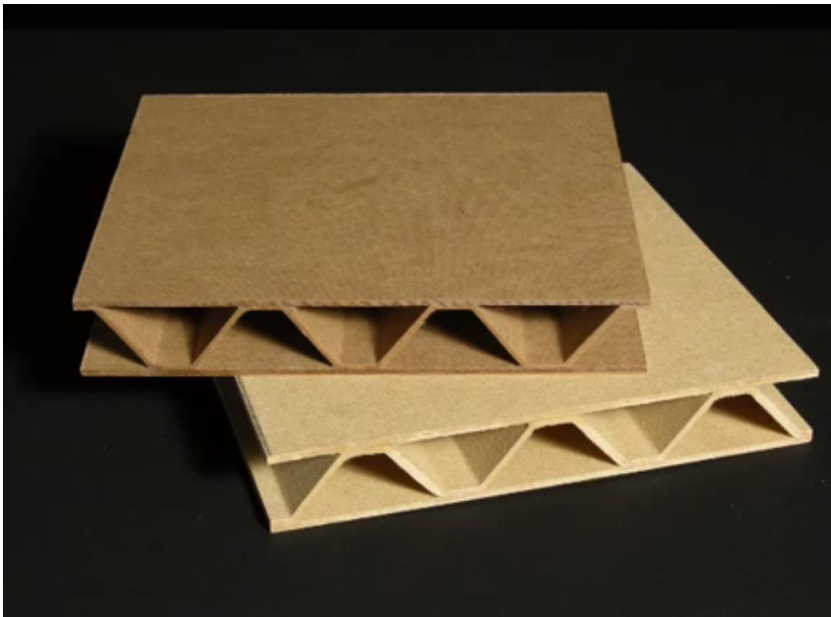
In the forested areas of the western United States, small trees and forest thinnings provide a ready fuel source for wild fires. These materials represent a possible source of fibers that can be made into adhesive-free three dimensional engineered fiberboard.



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Introduction

Economically viable production of 3-D engineered fiberboard (3DEF) depends on the processing methods of the fibers. All possible commercial applications of this material depend on the mechanical properties of the fiberboard.





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INTRODUCTION RESOURCES

Wikipedia article: Fiberboard

<http://en.wikipedia.org/wiki/Fiberboard>

Wikipedia article: Tree thinning techniques and processes

[http://en.wikipedia.org/wiki/Ecological thinning](http://en.wikipedia.org/wiki/Ecological_thinning)



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Organization Overview

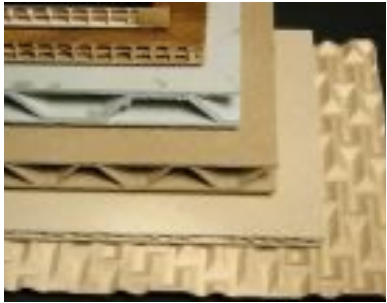


At the turn of the 19th century, logging had proceeded across much of the eastern United States and demands for wood products were rising rapidly. In 1910, the Forest Products Laboratory (FPL) was established in Madison, Wisconsin, to find ways to conserve scarce timber resources.

For almost 100 years, our mission has been to use our Nation's wood resources wisely and efficiently, while at the same time keeping our forests healthy. Our research began with preserving railroad ties, and now we are venturing into nanotechnology and finding ways that our research can contribute to mitigating the impacts of climate change.

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Organization overview



Advanced composites



Advanced structures



Nanotechnology



Forest Biorefinery

The FPL research staff has the experience and expertise needed to make us world renowned among forest products research organizations and an unbiased source of information. FPL researchers have longevity, with an average of 20 years of experience in their related fields.

The range of our wood research spans from fiber and chemical science to composites. We take pride in knowing that our research touches the American public's daily life. Whether it's putting a self-adhesive, environmentally friendly stamp on an envelope or walking on a hardwood floor, FPL has in some way contributed to making those products and innovations.



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Organization Overview Resources

Forest Products Laboratory

<http://www.fpl.fs.fed.us/index.php>

Forest Service

<http://www.fs.fed.us/>



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Problem Statement

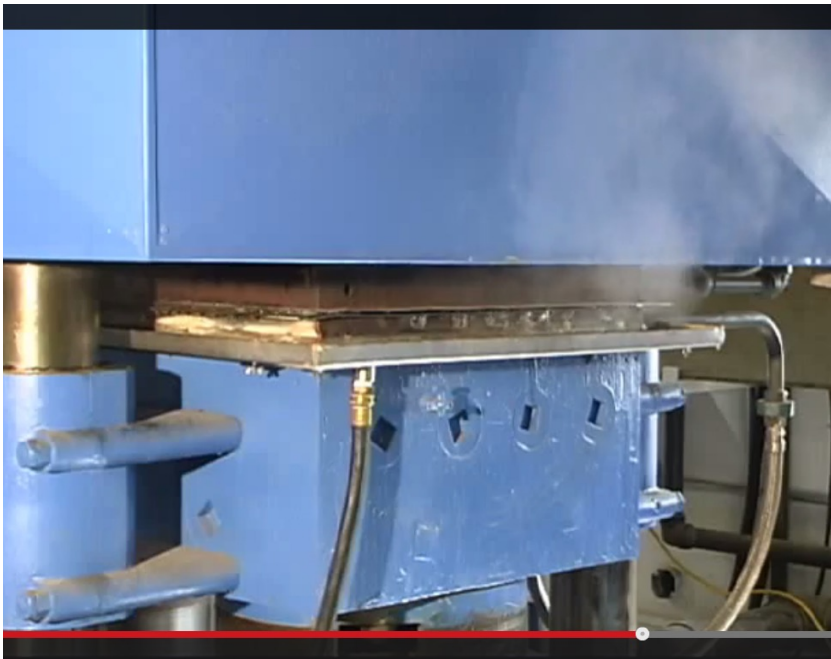


Three-dimensional engineered fiberboard can be used for a variety of applications including office furniture, structural panels, and packaging. In order to support production of these consumer products, the refining conditions of the wood fibers must be optimized to provide a high-value, marketable material.

Choice of refining conditions relies on creating repeatable mechanical properties for the material.

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Problem Statement



Scientists at the Forest Products Laboratory have fabricated forty 50- x 50-mm panels of fiberboard using 20 different processing methods. The variables in processing conditions include NaOH concentration, refiner plate gap, freeness, fiber length, shive content, and processing temperature.

These panels must now be evaluated for their mechanical properties so that the optimal processing conditions may be identified. The problem in this challenge is to create a series of scientific tests that will provide reliable data about the mechanical properties of the fiberboard panels.



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Problem Resources

Production methods for fiberboard

1. http://www.fpl.fs.fed.us/research/research_emphasis_areas/howdoesitapply.php?rea_id=1&view_id=2
2. <http://www.madehow.com/Volume-3/Fiberboard.html>
3. <http://www.ampersandart.com/tips/archivalinfo.html>

Forest Products Laboratory press release on use of forest-thinnings

http://www.wfpa.org/workspace/resource/document/newsline_forest_thinnings.pdf

Properties of hardboard

<http://en.wikipedia.org/wiki/Hardboard>

Standard test methods for lumber and wood-based structural material

<http://www.astm.org/Standards/D4761.htm>

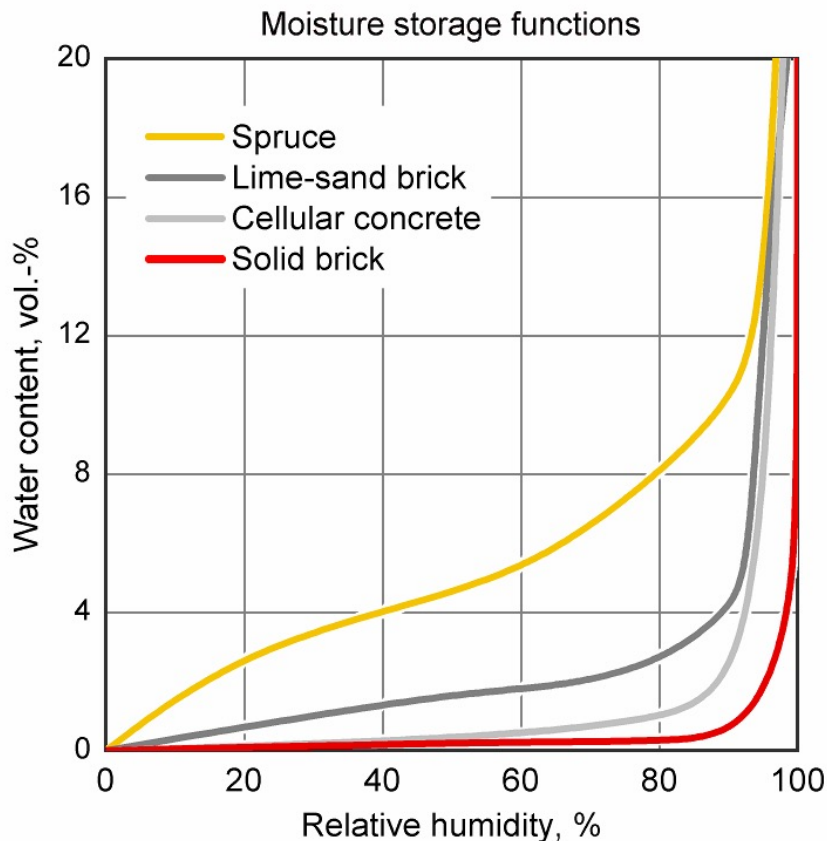
Tensile Energy Absorption

<http://cool.conservation-us.org/don/dt/dt3468.html>



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Discussion



Researchers at the Forest Products Laboratory have suggested that the 3-D engineered fiberboard be tested in such a way as to minimize the use of the panels of material. Non-destructive tests are preferred so that the samples of fiberboard may be preserved.

In addition, the testing methods need to take into account the various environmental conditions in which the finished commercial products might be used. Relative humidity levels, temperature extremes, and exposure to the elements (wind, rain, snow) are recommended for consideration in the testing plan.



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Discussion resources

Nondestructive testing of wood products

<http://www.woodcenter.org/docs/fplgtr70.pdf>

Edgewise bending of laminated veneer lumber

<http://connection.ebscohost.com/c/articles/9709064020/edgewise-bending-properties-laminated-veneer-lumber-effect-veneer-grade-relative>

Factors affecting the development of biodeterioration in wooden constructions.

<http://link.springer.com/article/10.1007%2FBF02473453>

The shrinking and swelling of wood and its effects on furniture.

<https://www.extension.purdue.edu/extmedia/fnr/fnr-163.pdf>

Masonite

<http://en.wikipedia.org/wiki/Masonite>





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Organization's Solution

Forest Products Lab decided to test their materials under two different environmental conditions: 50% and 90% relative humidity. They accomplished this by having two separate conditioned laboratories in which to store the panels.

Three tests that were conducted on the panels were: tensile, bending, and vibration. The tensile tests were conducted on an Instron Tensile tester, which FPL already owned. Standard ASTM D-1037 was followed in the testing.

Bending tests were also completed according to Standard ASTM D-1037.

To test for vibrations, the team constructed a non-destructive vibrations tester utilizing Computer Aided Design and machine shop facilities at FPL.

***The organization will be providing us with more information on the solution.





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Solution Resources

Nondestructive testing of wood products

<http://www.woodcenter.org/docs/fplgtr70.pdf>

ASTM D1037-12

